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THE PERFORMANCE OF MAINTENANCE TECHNICIANS ON THE JOB

J. Orlansky
J. String

August 1981

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Knowing how well maintenance technicians perform maintenance on the job is necessary in order to evaluate the effectiveness of training. This paper reviews data on one possible measure; specifically, the unnecessary removal of non-faulty parts during actions taken to identify and correct malfunctions in equipment. Such data may be found in the maintenance management data systems of the military services. (CONTINUED)

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These findings may be due to inadequate test equipment, tools, and maintenance manuals, as well as to inadequate training.

There is a need to collect data on the performance of maintenance technicians on the job in a way that can be related systematically to procedures used in military selection and training.

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ABSTRACT

Knowing how well maintenance technicians perform maintenance on the job is necessary in order to evaluate the effectiveness of training. This paper reviews data on one possible measure; specifically, the unnecessary removal of non-faulty parts during actions taken to identify and correct malfunctions in equipment. Such data may be found in the maintenance management data systems of the military services.

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ACKNOWLEDGEMENTS

We appreciate a suggestion made by Earl Alluisi of the Air Force Human Resources Laboratory that stimulated the preparation of this paper. Joyce Shields of the Army Research Institute provided some of the data.

ABBREVIATIONS

TAMMS	The Army Maintenance Management System
Ships 3-M	Naval Ships' Maintenance and Material Management System
Aviation 3-M	Naval Aviation Maintenance and Material Management System
66-1	Air Force Maintenance Management System (used by all Air Force organizations except Tactical Air Forces)
66-5	Air Force Maintenance Management System (used only by Tactical Air Forces)

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SUMMARY

A. PURPOSE

The purpose of this paper is to review data that describe the job performance of military maintenance technicians.

B. BACKGROUND

The effectiveness of military maintenance training is almost always evaluated on the basis of how well students perform at school, i.e., test scores at the completion of a course. An important question, however, is how well training at school prepares maintenance technicians to perform maintenance on the job. Little objective data are available on the job performance of maintenance technicians. Without such data, it is difficult to assess the effectiveness of maintenance training, an important issue in cost-effectiveness evaluations of military training.

Each military service operates a maintenance management data system that contains information on the conduct of all maintenance actions (or tasks), e.g., what equipment was maintained, why maintenance was required, what was done and who did it. Although these systems were not designed to answer questions about training, the present effort was an attempt to see wnether they might be used, in some way, for such purposes. The scope of the effort was limited to data on the unnecessary removal of good parts during actions taken to identify and correct malfunctions in equipment.

C. FINDINGS

According to seven studies, non-faulty parts were removed in 4 to 43 percent of all corrective maintenance actions, and account for 9 to 32 percent of all maintenance man-hours. One study reports that technicians failed to find a faulty part or damaged a good part in 10 percent of all maintenance actions.

Only limited efforts were made in these studies to examine why these amounts of ineffective maintenance were observed. Suggestions are offered that the reasons include inadequate test equipment, tools, and documentation, as well as inadequate training.

D. CONCLUSIONS

Available data, though limited in scope primarily to the unnecessary removal of non-faulty parts, offer strong evidence that maintenance technicians may conduct maintenance in an inappropriate and inefficient manner.

E. RECOMMENDATIONS

It is recommended that additional data be collected on the performance of maintenance technicians on the job to estimate not only the unnecessary removal of non-faulty parts but also the failure to remove faulty parts and damage caused to good parts while performing maintenance. Data are also needed to identify the factors that may lead to inappropriate maintenance, such as inappropriate test equipment, tools, documentation, and training among a number of possible factors.

I. INTRODUCTION

It is obvious that the performance of maintenance technicians is one of the factors that can influence the operational readiness of weapon systems in the field. Nevertheless, surprisingly little objective data are available to document how well technicians do what they are supposed to do. This paper summarizes the objective data that we were able to compile concerning the job performance of maintenance technicians.* Objective job performance data are needed to evaluate the effectiveness of procedures used by the military services to select and train maintenance technicians. At present, methods of selection and training are validated almost entirely on the basis of how maintenance technicians perform at school rather than on the job. Supervisors' ratings are sometimes used to evaluate training courses. This method of validation involves subjective judgments that may be influenced by impressions about motivation and cooperation that have little to do with capability to perform well on the job.

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*This study was performed for the Office of the Deputy Under Secretary of Defense for Research and Engineering (Research and Advanced Technology), under the technical cognizance of the Military Assistant for Training and Personnel Technology. It is one of a series concerned with Cost and Effectiveness Methods for Defense Training (DARPA TO T-134).

II. MAINTENANCE MANAGEMENT DATA SYSTEMS

The military services operate large data management systems to provide detailed information on the current maintenance status of military equipment. These data systems are identified in Table 1. The general purpose of these systems is to provide information needed to manage the maintenance of weapons and support equipment, the availability of spare parts, the types of malfunctions that are being encountered, and so on. These systems were designed to provide information needed for purposes of maintenance and logistics and not about the performance of military technicians.

TABLE 1. MAINTENANCE MANAGEMENT DATA SYSTEMS USED BY THE MILITARY SERVICES

Service	Maintenance Management System	
	Name	Short Title
Army	The Army Maintenance Management System	TAMMS
Navy	Naval Ships' Maintenance and Material Management System	Ships' 3-M
Navy	Naval Aviation Maintenance and Material Management System	Aviation 3-M
Air Force	Air Force Maintenance Management Systems	66-1 and 66-5

The possibility of using data available in these systems to describe the performance of maintenance technicians in the field has been examined (see String and Orlansky, 1981). As presently constituted, these systems cannot provide information useful for assessing the on-the-job effectiveness of alternative methods of selection and training. The ability to identify and track individuals is a mandatory requirement of any attempt to relate criteria for selection or method of training to performance on the job. The names of individuals who perform maintenance actions are not kept in the permanent records maintained in the central data files of each service. Maintenance records, which include names of personnel who did the work, are kept only at the field activities, but they are discarded after 6 months. The use of maintenance records with personal identification for analytical purposes would require special methods of processing in order not to infringe on provisions of the Privacy Act. Even so, such records are not precise enough to distinguish what parts of a maintenance action were performed by a particular individual, especially when the work is performed over more than one shift. The practice of cross-skill maintenance, that is, to train individuals to maintain a wide variety of equipment under combat conditions, assigns individuals to tasks for which they were not trained at school; this practice would complicate any analytical effort to relate training at school to performance on the job. In brief, it was concluded that presently available maintenance data records cannot be used to assess the effectiveness on the job of various methods of training at school. It is conceivable that these systems could be modified to provide the data that would be needed, but that is not the subject of this paper.

III. DATA ON INCORRECT MAINTENANCE ATTRIBUTED TO PERSONNEL

Certain information collected by the maintenance management data systems may be used to make inferences about the quality of performance of maintenance technicians in the actual environment of day-to-day work. Specific examples concern data on components removed erroneously, i.e., components removed for replacement or repair that were found later not to contain any malfunction; another would be a report of no malfunction when one was found immediately afterwards. Such data may be used to characterize the work of a group of technicians in a particular work center; it does not identify particular individuals and therefore cannot be related to their individual characteristics with respect to test performance when selected or method of training prior to their current assignment. Some qualifications about the use of data on the removal of non-faulty parts will be discussed later.

A. NAVY F-14A AIRCRAFT

According to Gold, Kleine, Fuchs, Ravo, and Inaba (1980) maintenance technicians can produce three kinds of errors in organizational maintenance: replace a good unit, fail to replace a bad unit, or damage the system in some way (see Table 2). Some of these errors can produce significant effects, e.g., abort an operation, require repetition of the troubleshooting and repair activity, waste spare parts, place an additional load on the maintenance activity, or perhaps lead to an injury or accident.

TABLE 2. KINDS OF MAINTENANCE ERRORS

Type of Error	Explanation of Error	Typical Source of Error
I	Removal of functioning equipment: technician replaces a unit that has not malfunctioned.	Troubleshooting
II	Failure to remove faulty equipment: technician fails to recognize a unit that has malfunctioned or has been improperly handled.	Troubleshooting; checkout
d	Damage to equipment: technician fails to accomplish a corrective or preventive action properly.	Removal/installation; service; repair; adjust/align.

Source: Gold, Kleine, Fuchs, Ravo, and Inaba (1980), p. 12

Gold, Kleine, Fuchs, Ravo, and Inaba (1980) used data from the Naval Aviation Maintenance and Material Management System (Aviation 3-M) to describe the readiness status of six F-14A squadrons (72 aircraft) over a period of 1 year (Table 3). At any given time, 5.09 (42 percent) of the 12 aircraft in each squadron were not ready for operational assignments, for maintenance conditions given in the table; two (17 percent) of the aircraft were not ready because of unscheduled maintenance. Each F-14A aircraft required an average of 43 man-hours of organizational level maintenance for each hour of flight (Table 4); over 16 (38 percent) of these man-hours were devoted to corrective maintenance.

An analysis was made of the frequency of each type of corrective maintenance (CM) error according to responsible work center, Table 5. Nearly 14 percent of remove and replace operations (4 percent of all CM actions) involved removals of functioning equipment (a Type I error); nearly 10 percent of all CM actions failed to remove faulty equipment (a Type II error) or resulted in damage to equipment (a Type d error). Nearly 14 percent of all CM actions resulted in one of these error conditions.

TABLE 3. READINESS CONDITION OF AN AVERAGE SQUADRON OF F-14A AIRCRAFT OVER ONE YEAR
(12 aircraft per squadron)

Operational Status of Aircraft	Maintenance Condition	Average Number of aircraft: Number	Average Number of aircraft: Percent
Ready	Full systems capable	6.20	51%
	Reduced material condition due to unscheduled maintenance	.38	3
	Not fully equipped	.39	3
	Total	6.97	58%
Not ready	Due to scheduled maintenance	.48	4%
	Due to unscheduled maintenance	2.00	17
	Due to supply	2.61	22
	Total	5.09	42%
	TOTAL	12.06	100%

SOURCE: Gold, Kleine, Fuchs, Ravo, and Inaba (1980) p. 70

TABLE 4. ORGANIZATIONAL MAINTENANCE MAN-HOURS PER FLIGHT HOUR IN SIX SQUADRONS OF F-14A AIRCRAFT

Maintenance Category	Man-hours Per Flight Hour: Number	Man-hours Per Flight Hour: Percent
Planned maintenance (PM)	19.2	44%
Corrective maintenance (CM)	16.4	38
Support actions (SAF)	6.4	15
Technical directive compliance (TDC)	1.2	3
TOTAL	43.2	100%

SOURCE: Gold, Kleine, Fuchs, Ravo, and Inaba (1980), p. 71

TABLE 5. SUMMARY OF CORRECTIVE MAINTENANCE ERRORS FOR F-14A AIRCRAFT

Work Center	Type I[a,d]	Type I[a,e]	Type II/d[b,e]	All Errors[e]
Organizational Maintenance Department	14.5%	4.0%	9.8%	13.8%
Power Plants (110)	6.7	1.3	15.9	17.2
Airframe (120)	7.8	1.4	16.0	17.4
Corrosion Control (121)	0	0	6.4	6.4
Aviator Equipment (131)	0	0	4.1	4.1
Safety Equipment (132)	20.2	4.4	11.0	15.4
Electronics (210)	14.8	4.1	8.5	12.6
Electrical Instruments (220)	20.1	4.3	6.7	11.0
Armaments (230)	6.1	1.2	6.6	7.8
Electro-Weapons Control (232)[c]	18.0	8.4	7.3	15.7
Troubleshooters (320)	0	0	12.5	12.5

[a]Removal of non-faulty parts
[b]Failure to recognize a malfunction/damage induced by technician
[c]Includes AN/AWG-9 Radar that accounted for over 60 percent of CM actions and errors
[d]Expressed as percent of RR jobs
[e]Expressed as percent of all CM jobs

All CM actions are the sum of: TS + RIP + RR + CANN
where: TS = Total Troubleshoot Jobs
RIP = Total Repair-In-Place Jobs
RR = Total Remove-and-Replace Jobs
CANN = Total Cannibalization Jobs

All Errors are the sum of: EI + EIID
where: EI = Total Errors of Type I
EIID = Total Errors of Type II or d

SOURCE: Gold, Kleine, Fuchs, Ravo, and Inaba (1980), p. 74
Private conversations with David Gold and Sal Ravo, XYZYX Information Corporation.

The Aviation 3-M system does not report directly that technicians have produced various types of errors; this is inferred by Gold, Kleine, Fuchs, Ravo, and Inaba (1980) in the Tables shown above. In the Aviation 3-M system, the Aircraft Intermediate Maintenance Department Report cites cases where "no defects" were found in components removed from aircraft. Gold, Kleine, Fuchs, Ravo, and Inaba (1980) call these "unjustified removals" (Type 1 error). This interpretation does not seem appropriate in all cases. Consider the following situations: (1) a technician removed a component because the test equipment available to him was not capable of isolating a malfunction to a single system element (i.e., it could localize the fault to a group of black boxes of which only one was found later to be faulty); (2) two elements of a system, one highly interactive so the one element will function correctly with one article (black box) of the second element but not with a second black box of the same model. When under pressure to meet a required flight time, a technician may knowingly replace a number of black boxes, without testing, to be certain that the faulty one is replaced prior to flight time.

Gold, Kleine, Fuchs, Ravo, and Inaba (1980) also inferred failures to remove faulty equipment or faulty repair (Type II and Type d errors) in cases where their analyses related observed malfunctions to previous reports of failure to find any malfunction in the same components. Some of these cases may have involved temporary "quick-fixes," e.g., tightening a connector or fastener known to be degraded. As noted elsewhere in this paper, the Aviation 3-M maintenance data system was designed to provide information on the status of equipment and not on the quality of human performance as a possible source of certain malfunctions.

B. ARMY RECONNAISSANCE VEHICLE TURRETS

A recent study of organizational level support in an Army brigade-sized unit produced similar results. In the Army, parts found to be faulty during organizational maintenance are submitted for exchange to a shop which performs direct support maintenance. A Maintenance Request Form (DA 2407) is filled out for each exchange. Dressel and Shields (1979) determined whether the parts submitted for repair over a period of 1 year were found later to be faulty; attention was limited to the turret of the Armored Reconnaisance Airborne Assault Vehicle (M 551). On behalf of the study, the maintenance shop manager completed a special form (ARI SF 77-1) which recorded the specific repairs required and other information of interest for each part that was exchanged. The main findings are summarized in Table 6. Almost half (42 percent) of the items submitted for repair were not faulty; 32 percent of all man-hours spent in the repair shop were applied to items found not to contain a fault.

TABLE 6. ANALYSIS OF ITEMS REMOVED FOR MAINTENANCE PURPOSES FROM TURRETS OF THE ARMORED RECONNAISSANCE AIRBORNE ASSAULT VEHICLE IN AN ARMY BRIGADE FOR 1 YEAR
(Data from Dressel and Shields, 1979)

Data On Removals	Total	Non-Faulty Items	
		Number	Percent
Requests for repair	584	246	42%
Repair time	1146 hrs	367 hrs	32
Average time in shop	5.6 days	4.0 days	71
Average repair time[a]	2.3 hrs	1.5 hrs	65
Cost of items submitted for repair	$1.24 M	$0.36 M	29

[a]Confirmed malfunctions only.

C. NAVY EA-6B, E-2C, SH-3H, AND S-3A AIRCRAFT

Jewell and Webman (1979) analyzed maintenance records on all Navy EA-6B, E-2C, SH-3H, and S-3A aircraft for 1977 as reported in the Naval Aviation Maintenance and Material Management System (Aviation 3-M). This data base accounted for a total of about 1.8 million man-hours of maintenance work and about 385,000 maintenance actions. Attention was given primarily to "no-defect maintenance" defined as unscheduled maintenance on components for which no corrective action was required (See Table 7). About 15 percent of all actions both in organizational and intermediate maintenance were on items found not to have any defects; about 17 percent of the man-hours in organizational maintenance and about 9 percent of the man-hours in intermediate maintenance were expended on items found not to have any defects. On the basis of interviews with maintenance personnel, Jewell and Webman (1979) conclude that maintenance is performed on items found not to have defects because of inadequate built-in test equipment that cannot isolate equipment

TABLE 7. AMOUNT OF MAINTENANCE ACTIVITIES ON NAVAL AIRCRAFT WHERE NO DEFECT WAS FOUND, 1977
[Source: Jewell and Webman (1979)]

Leval of Maintenance	Maintenance Activities, 1977[a]			
	Man-Hours		Maintenance Actions	
	Total (000)	Percentage due to Removal of No-Defect Items	Total (000)	Percentage due to Removal of No-Defect Items
Organizational	1119	17.0%	322	14.8%
Intermediate	650	9.3	63	16.1

[a]Data for maintenance on all Navy EA-6B, E-2C, SH-3H, and S-3A aircraft during 1977 as shown in Naval Aviation Maintenance and Material Management System.

test equipment that cannot isolate equipment failure, because system complexity precludes simple fault isolation, and because systems integration requires personnel to be knowledgeable in several systems without adequate training on all of them. These explanations are based on the interviews; although they appear reasonable, no data are offered to support these conclusions.

D. ARMY ELECTRICAL AND VEHICULAR COMPONENTS

"In a test conducted at Fort Carson, Colorado, an average of 35 percent of the generators, regulators, alternators, distributors, and starters returned as unusable were actually serviceable".* According to the Brown Board Survey 1966, 43 percent of the vehicular components removed as faulty in field maintenance were found later to be good.

E. AIR FORCE A-7D, F-111A, AND F-4D AIRCRAFT

Johnson and Reel (1973) report that 9 to 13 percent of the components removed for failure on three types of aircraft (A-7D, F-111A, and F-4D) were found later in the shop to be serviceable; note that these data refer to percent of components removed that were found to be good rather than percent of maintenance actions in which good parts were removed. Johnson and Reel also report that 85 percent of the good parts removed came from avionics systems; the remainder came from airframe and utility systems, propulsion, instruments, and autopilots.

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*This statement appears in Buchan and Knutson, 1977. The study, Troubleshooting Test Conducted by the USAMMCS at Fort Carson, CO, 1-31 July 1974, was not seen. A relevant table from that study and information about the Brown Board Survey were provided by J. Shields of the Army Research Institute.

F. ARMY UH-1H, CH-47C, AND CH-57B HELICOPTERS

The maintenance of Army helicopters was analyzed because "over 50% of Army aircraft maintenance diagnoses at organizational level were reported as being incorrect by a high-ranking military official. U.S. Army Agency for Aviation Safety (USAAAVS) reported that poor inspections and/or improperly performed maintenance actions were frequently the cause of helicopter mishaps" (Holbert and Newport, 1975, p. 24).

An analysis of over 5000 maintenance records of the UH-1H and CH-47C helicopters (6 months each) and of maintenance records of 8500 flight hours for the CH-54B helicopter (30 months) showed that there were 0.23, 0.32, and 0.07 repetitive maintenance actions (respectively) per flight hour; these maintenance actions apply to the same malfunctions on the same aircraft reported frequently over short time periods. Total maintenance actions, including those for non-repetitive malfunctions, were not reported. The repetitive actions identify frequently recurring malfunctions, e.g., altitude indicator, high engine oil temperature, fuel-low light, engine exhaust duct. About half of the repetitive maintenance actions are attributed to inadequate test equipment, troubleshooting, and standard maintenance practices; about 20 percent are attributed to inadequate training, tools, and maintenance manuals.

Holbert and Newport tried to determine the frequency of incorrect diagnoses of malfunctions by comparing records submitted by the organizational-level maintenance activity with those for the same components at depot-level overhaul and inspection. Records of maintenance of the UH-1H and CH-47C helicopters at three operational bases and two depots for a 6-month period were examined. It was found that depots are not required to use the organizational-level form (DA Form 2410) with diagnostic information if they use assembly-line production methods for overhaul. Therefore, an objective comparison

of diagnoses of malfunctions could not be made. On the basis of interviews with personnel at the depots, it was estimated that 15 to 25 percent of transmissions going through overhaul are found to have no defects or malfunctions.

G. ARMY HELICOPTERS

Reilly (1977) reviewed reports of 13,037 mishaps to six classes of Army helicopters from 1969 to 1976. The overall proportion of mishaps attributed to maintenance error was 5.7 percent. Most errors were attributed to factors other than errors in maintenance, such as materiel malfunction (52 percent) and crew error (29 percent); the total cost of all mishaps in this sample was $270 million. Since this study does not report information on the removal of non-faulty parts, it is not included in the discussion that follows.

IV. DISCUSSION

A summary of these studies of the removal of non-faulty parts during corrective maintenance appears in Table 8. The removal of non-faulty parts occurs in 4 to 43 percent of all corrective maintenance actions in these data; the median value of 11 data sets is 15 percent. The removal of non-faulty parts accounts for 9 to 32 percent of all maintenance man-hours (for three cases where such data were reported). According to one study, technicians fail to find a faulty part or damage a good part in about 10 percent of all corrective maintenance actions (Gold, Kleine, Fuchs, Ravo, and Inaba, 1980).

These data suggest that inadequate performance by technicians is a factor that contributes to the "not-ready" status of military equipment. Other factors would include the unavailability of spare parts, test equipment, and up-to-date technical documentation. For example, Gold, Kleine, Fuchs, Ravo, and Inaba (1980) estimate that over a 1-year period, an average of 22 percent of the F-14A aircraft were not ready for reasons due to supply. According to a questionnaire, about 50 percent of 551 Army technicians believed that repetitive maintenance (same malfunction) of Army helicopters was due primarily to inadequate test equipment, troubleshooting, and standard maintenance practices; about 20 percent gave inadequate training, tools, and maintenance manuals as a secondary cause (Holbert and Newport, 1975). These findings appear to identify a significant problem in military maintenance but do not suggest a means to its solution.

TABLE 8. SUMMARY OF STUDIES OF ORGANIZATIONAL ECHELON CORRECTIVE MAINTENANCE WHERE NON-FAULTY PARTS WERE REMOVED

Equipment or System	Size of Sample	Period of Observation	Data Source	Corrective Maintenance Where Non-Faulty Parts Were Removed			References
				Maintenance Echelon	Percent of Actions	Percent of Man-Hours	
F-14A Aircraft	72 Aircraft	1 yr	3M and analyses	Organizational	4%		Gold, Kl.ine, Fuchs, et al., 1980, and private conversations with the authors
Armored reconnaissance and airborne assault vehicle (M 551)	Brigade	1 yr	Maintenance Request Form (DA 2407) and special form for study	Organizational	42	32%	Uressel and Shields, 1979
Aircraft: EA-6B, C-2C, SH-3H, S-3A	All Navy 1.8M man-hours 0.4M actions	1 yr	3M and interviews	Organizational Intermediate	15 16	17 9	Jewell and Webman, 1979
Electrical components: generators, regulators, alternators, distributors, starters	Fort Carson CO	1 mo		Organizational	35		Buchan and Knutson, 1977
Vehicular components				Organizational	43		Brown Board Survey, 1966
Aircraft: A-7D F-111A F-4D				 Organizational Organizational Organizational	 12.9[a] 9.0[a] 8.8[a]		Johnson and Reel, 1973
Helicopters UH-1H	82[b]	6 mo	Component removed and repair/overhaul Record (DA 2410)	Organizational	15 to 25[c]		Holbert and Newport, 1975
CH-47C	123[d]	6 mo		Organizational	15 to 25[c]		

a. Percent of total removals found serviceable; values estimated from a graph.
b. Number of records with failure code data; 53 other records (39 percent) had no failure code.
c. Estimated percent of transmissions found at depot to contain no defects, as reported by personnel in interviews. Due to inadequate records, study not able to compare defects reported at organizational level with those found later at depots.
d. As above, 13 other records (10 percent) had no failure code.

The data sample is small and may not be representative. The removal of non-faulty parts may not always be an inappropriate action, e.g., the test equipment may malfunction or not be capable of distinguishing between a faulty and non-faulty part; if the technician is under pressure to have equipment ready for a mission, he may remove and replace a large number of components without sufficient tests in order to make sure that all possible malfunctions have been removed. Finally, the data apply to all maintenance actions within a large unit and not to the performance of particular individuals.

One particular value of data describing the quality of performance of maintenance personnel on jobs in operational settings would be their use in validating selection standards for recruiting and assigning to career paths and evaluating the effectiveness of various methods of training (e.g., conventional instruction compared to computer-based instruction, use of maintenance training simulators as opposed to actual equipment training). As a general matter, the effectiveness of military selection and training has been evaluated on the basis of performance of technicians at school and not on the job. The latter is the more relevant criterion.

It is conceivable that the data generated through maintenance management systems of the military services could be modified to provide information on the performance of maintenance technicians. These systems were designed primarily to manage maintenance services and cannot be faulted for not providing information about personnel relevant to selection and training. A prototype system for providing some of this information has been developed and is now being tested by the U.S. Army Research Institute (Katz and Drillings, 1981). Called the Army Maintenance Performance System, it records the work experience (time on each technical task in the maintenance battalion) and training (courses and qualification tests) of each maintenance technician. This record system is not planned

to be part of The Army Maintenance Management System; it would be used by work supervisors and training managers; each soldier would carry his own record of experience and skill history. It does not appear that this record system would contain information about effective and ineffective performance, e.g., time to diagnose malfunctions, success and failure to diagnose malfunctions of various types.

V. FINDINGS

Listed below are the major findings resulting from this study.

1. Non-faulty components are removed in 4 to 43 percent of all corrective maintenance actions and account for 9 to 32 percent of all maintenance man-hours.
2. Technicians fail to find a faulty part or damage a good part in about 10 percent of all corrective maintenance actions.
3. Maintenance technicians believe that repetitive maintenance for the same malfunction is due primarily to inadequate test equipment, troubleshooting, and standard maintenance practices, and secondarily to inadequate training, tools, and maintenance manuals.
4. These findings are based on seven studies reported from 1975 to 1980. Diagnostic studies are needed to clarify the extent to which human performance affects the quality of maintenance in different types of weapon and support systems and to identify ways of improving the personnel aspects of maintenance.
5. Data on the performance of maintenance technicians on the job should be collected in a way that can be related to procedures used in military selection and training.

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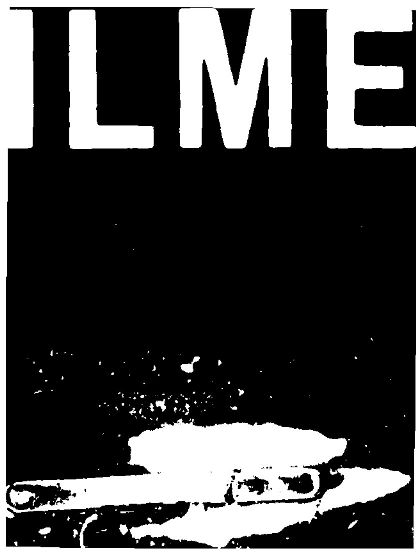
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